

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**OPEN CHANNEL**

(ft)

**CODE 582**

**Definition**

Constructing or improving a channel either natural or artificial, in which water flows with a free surface.

discharge by gravity flow or pumping, and where excavation or other channel work does not cause significant erosion, flooding, or sedimentation.

**Scope**

This standard applies to construction of open channels or modifications of existing streams or ditches. Design criteria for channel stability and maintenance of floodwater diversions (400), floodways (404), or surface drainage, main or lateral (608), having a drainage area in excess of 1 mi<sup>2</sup> (1.6 km<sup>2</sup>) shall be in accord with this standard for open channels. It does not apply to diversions (362), grassed waterways (412), irrigation field ditches (388), surface drainage, field ditches (607), or irrigation canals or laterals (320).

**Design criteria**

**Plan.** Channel construction or modification shall be according to an approved plan prepared for the site. TR-25 shall be used in surveys, planning, and site investigations for channel work. Design criteria in TR-25 shall be followed, using the procedure best adapted to site conditions.

In selecting the location and design of channels, careful consideration shall be given to minimizing water pollution, damage to fish and wildlife habitat, and to protecting forest resources and the quality of the landscape. In considering requirements for construction and operation and maintenance, selected woody plants must be preserved. The overall landscape character, prominent views, and fish and wildlife habitat requirements must be considered.

**Purpose**

To provide discharge capacity required for flood prevention, drainage, other authorized water management purposes, or any combination of these purposes.

Planned measures necessary to mitigate unavoidable losses to fish or wildlife habitat shall be included in the project. The quality of the landscape shall be maintained by both the location of channel works and plantings, as appropriate.

**Conditions where practice applies**

This standard applies to all earth channel construction or modification except as noted under "Scope."

It also applies where stability requirements can be met, where the impact of the proposed construction on water quality, fish and wildlife habitat, forest resources, and quality of the landscape is evaluated and the techniques and measures necessary to overcome the undesirable effects are made part of any planned work, where an adequate outlet for the modified channel reach is available for

The alignment of channels undergoing modification shall not be changed to the extent that the stability of the channel or laterals thereto is endangered.

**Capacity.** The capacity for open channels shall be determined according to procedures applicable to the purposes to be served and according to related engineering standards and guidelines in handbooks. The water surface profile or hydraulic gradeline for design

flow shall be determined according to guidelines for hydraulic design in TR-25. The  $n$  value for aged channels shall be based on the expected vegetation, along with other retardance factors, considering the level of maintenance prescribed in the operation and maintenance plan prepared with the owners or sponsors. The required capacity may be established by considering volume-duration removal rates, peak flow, or a combination of the two, as determined by the topography, purpose of the channel, desired level of protection, and economic feasibility.

**Cross section.** The required channel cross section and grade shall be determined by the plan objectives, the design capacity, the materials in which the channel is to be constructed, the vegetative establishment program, and the requirements for operation and maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. Urban and other high-value developments through which the channel is to be constructed must be considered in the design of the channel section.

**Channel stability.** Characteristics of a stable channel are:

1. The channel neither aggrades nor degrades beyond tolerable limits.
2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.
3. Excessive sediment bars do not develop.
4. Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel.

All channel construction and modification (including clearing and snagging) shall be according to a design that can be expected to result in a stable channel that can be maintained at reasonable cost. Vegetation, riprap, revetments, linings, structures, or other measures shall be used if necessary to insure stability.

The method applicable to site conditions in TR-25 shall be used in determining the stability of proposed channel improvements.

Bankfull flow is the flow in a channel that creates a water surface at or near the normal ground elevation, or the tops of dikes or continuous spoil banks that confine the flow for

a significant length of a channel reach.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective design life (aged condition). Channel stability shall be determined for discharges under these conditions as follows:

1. As-built condition – Bankfull flow, design discharge, or 10-year frequency flow, whichever is smallest, but not less than 50 percent of design discharge.

The allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel may be increased by a maximum of 20 percent if:

- a) The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation,
- b) Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and
- c) The channel design includes detailed plans for establishing vegetation on the channel side slopes.

2. Aged condition – Bankfull flow or design discharge, whichever is larger, except that it is not necessary to check stability for discharge greater than the 100-year frequency.

Stability checks that are flow related are not required if the velocity is 2 ft/s (0.6 m/s) or less.

For newly constructed channels in fine-grained soils and sands, the  $n$  values shall be determined according to procedures in chapter 6 of TR-25, and shall not exceed 0.025. The  $n$  value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

**Appurtenant structures.** The channel design shall include all structures required for proper functioning of the channel and its laterals, as well as travelways for operation and maintenance. Inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the channel design. The design also shall provide for necessary flood gates, water-level-control devices, bays used in connection with

pumping plants, and any other appurtenances essential to the functioning of channels and contributing to attainment of the purposes for which they are built. If needed, protective structures or treatment shall be used at junctions between channels to insure stability at these critical locations.

The effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, and inlet structures for surface and subsurface drainage on the channel and laterals thereto shall be evaluated to determine the need for modification or replacement.

Culverts and bridges that are modified or added as part of channel projects shall meet reasonable standards for the type of structure and shall have a minimum capacity equal to the design discharge or state agency design requirements, whichever is greater. Capacity of some culverts and bridges may need to be increased above the design discharge.

**Disposition of spoil.** Spoil material from clearing, grubbing, and channel excavation shall be disposed of in a manner that will:

1. Not confine or direct flows so as to cause instability when the discharge is greater than the bankfull flow.
2. Provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed.
3. Not hinder the development of travelways for maintenance.
4. Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
5. Direct water accumulating on or behind spoil areas to protected outlets.
6. Maintain or improve the visual quality of the site to the extent feasible.

**Vegetation of channel.** Vegetation shall be established on all channel slopes, berms, spoil, and other disturbed areas according to the SCS standard for channel vegetation (322).

## Operation and maintenance

**Plan.** An operation and maintenance plan must be prepared for each channel system. Minimum requirements for operation, maintenance, and replacement shall be consistent with the design objectives. This includes consideration of fish and wildlife habitat, quality of the landscape, water quality, mitigation features, methods, equipment, costs, stability, function for design life, frequency, and time of year for accomplishing the work. Detailed provisions for operation and maintenance must be made if complex features, such as water-level-control structures and pumping plants, are required.

**Maintenance access.** Travelways for maintenance generally shall be provided as part of all channel work. This requirement may be met by providing ready access points to sections of the channel if this will permit adequate maintenance in conformance with the operation and maintenance plan.

A travelway shall be provided on each side of large channels if necessary for use of maintenance equipment. Travelways must be adequate for movement and operation of equipment required for maintenance of the channel. The travelway may be located adjacent to the channel on a berm or on the spread spoil. In some places the channel itself may be used as the travelway. The travelway, including access points, must blend into the topography, the landscape, and adjacent land uses.

**Safety.** Open channels can create a safety hazard. Appropriate safety features and devices should be installed to protect people and animals from accidents such as falling or drowning.

## PLANS AND SPECIFICATIONS

Plans and specifications for constructing open channels shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

## PLANNING CONSIDERATIONS FOR QUANTITY AND QUALITY

### Quantity

1. Effects on components of the water budget, especially on volumes and rates of runoff and infiltration.

### Quality

1. Effects of erosion and the movement of sediment and soluble and sediment-attached substances in runoff during and immediately after construction.
2. Effects of the use of chemicals during vegetation control.
3. Effects of changes in channel vegetation on downstream water temperature.
4. Potential for temporary and long-term effects on the visual quality of downstream waters.

## STANDARD

### Scope

This standard applies to the design and construction of open project channels in flatland areas. Flatland here is defined as land where the natural surface drainage is inadequate. Slopes will normally be less than one tenth of one percent (0.1%). This standard is divided into three parts: formulas for use in channel design; stable channel design; and channel design for urban protection.

Part I. Formulas for use in channel design in flatland agricultural areas.

### Design Criteria

### Planning

For large channel systems in the RC&D and PL-566 watershed programs, the design must be oriented to the needs of the watershed, the desires of the sponsors, and the capacity of the outlet to accommodate the proposed discharge. Sponsors should be advised of any

outlet limitations, of increased costs of rights-of-way, bridges, etc., and other problems in order to assist them in arriving at the degree of protection needed or desired. Consideration should be given to planning for a specific level of protection.

For general farm crops the level of protection planned normally used is the 3-year frequency. For high value crops, with a low tolerance to excess water, a higher level of protection may be desired.

### Capacity

The required capacity shall be determined by the use of the Cypress Creek Drainage Formula. It is expressed as  $Q = CM^{5/6}$ . Please note that this formula expresses the discharge (Q) as a removal rate and not a peak flow. A complete description of this formula and the relationship of the variable "C" to "degree of protection" is given in Chapter 5 of NEH-16.

At channel junctions, the discharge from each contributing lateral will be added to determine the required discharge below the junction.

Allowance for initial sedimentation is taken care of by increasing the required discharge. This increase will normally be in between 10 to 20 percent. There will be no need to further deepen the channel after design.

Part II. Stable channel design.

### Planning

During this stage, a field reconnaissance of the channels under study should be made to identify potential stability problems. Information from this reconnaissance will be useful for project formulation purposes and for determining the limitations imposed by stability problems in meeting project objectives.

Soil sampling is an integral part of channel stability studies. At least two channels within the area should be selected for sampling. One of these channels should represent the average conditions and the other, the worst conditions. Sufficient borings will be taken to obtain the complete

range of soil characteristics to a depth at least 2 feet below the estimated design bottom. Normally, the upper, middle, and lower reaches of each selected channel will be investigated. The type of sampling will be in accord with the problems anticipated. (i.e. bank stability, excessive velocities, etc.).

Channels will be designed to be stable. National policy is stated in the NEM, Part 501 and design procedures are contained in TR-25.

### Part III. Channel design for urban protection.

#### Planning

Local sponsors make decisions regarding project objectives for PL-566 watershed and RC&D projects. The SCS has the responsibility of informing the sponsors of all the opportunities available under the Acts. Alternatives should be considered early in the planning phase to allow for maximum consideration. If an urban area is involved and urban protection is not a project objective, the work plan should clearly show this so that a false sense of security will not develop in the minds of the town people.

#### Design

One of the following conditions is usually encountered in channel design:

#### Condition A. Urban protection is a project purpose.

The proposed project channel serves an urban area. For this condition, the provisions given in the Watershed Protection Handbook must be followed (100-year protection).

#### Condition B. Urban protection is not a project purpose.

The proposed project channel serves an urban area that has installed, or plans to install, a storm drainage system. The project channel must be designed to provide an adequate outlet for the town drainage system.

#### Condition C. Conditions are the same as

condition B, except the town does not have and does not plan to install a storm drainage system. The project channel will be designed to carry the peak flow from a storm of the same frequency as the removal rates and used for the adjacent agricultural areas.

#### Capacity

Several methods are available to use in calculating peak discharges. NEH-4 describes the hydrograph method of calculating discharges. The EFM – Chapter 2 method is useful for small areas. The publication “Floods in Louisiana, Magnitude and Frequency” may be used over a large area of the state. For very flatlands (slope less than 0.1%), the EWP Technical Guide No. 40 gives reasonable values.

### SPECIFICATION

#### Design

All plans and designs will be in keeping with the Engineering Standard for Open Channel.

#### General Requirements

Construction operations will be carried out in such a manner that erosion and air and water pollution will be minimized and held within legal limits.

#### Construction

##### Clearing

Where a new channel is to be enlarged from one side only, the minimum area to be cleared shall be from the outer edge of the channel opposite the spoil to the outer edge of the unsprayed spoil, including allowance for the berm.

Where an existing channel is to be enlarged from one side only, the minimum area to be cleared shall be that given above for a new channel; except (1) trees and brush may be left on the opposite channel bank above the hydraulic gradient, or (2) trees and brush may be left on the opposite channel bank providing the cross sectional area of the channel is increased in an amount equal to or greater than the cross sectional area of the channel occupied by the trees and brush. The technician should

determine that such trees and brush left on the channel bank will not be undermined to the extent that they will fall and block the channel.

Where a new or existing channel is to be excavated from both sides, the minimum area to be cleared shall be from the outer edge of the unspread spoil on one side to the outer edge of the unspread spoil on the side opposite. Allowance shall be made for the two berms. Where spoil is to be spread, the area to be occupied by the spread spoil shall be cleared.

Clearing shall consist of the removal of trees, brush, and other debris.

Trees and other woody vegetation shall be cut off as near the ground surface as conventional tools or field conditions will permit, or as designated in the construction plans or details.

Stumps within the area to be excavated shall be grubbed or cut off to the extent that remaining roots and stumps shall not interfere with the operation or maintenance of the channel.

Cleared and grubbed debris shall be disposed of by burning, placing outside the construction area, or as otherwise directed.

#### Clearing and Snagging

See Engineering Standard and Specification, Clearing and Snagging.

In addition, a minimum 10-foot wide berm shall be provided on one side of the channel for ingress and egress of servicing and maintenance equipment.

#### Clearing and Shaping

This is identical to clearing and snagging as given above, and in addition the bottom and sides of the channel shall be shaped to be reasonably smooth.

Report as Clearing and Snagging, Code 326.

#### Excavation

Channels shall be constructed to the lines and grades as shown on the plans, and as staked in the field. The finished section shall be generally smooth and of good appearance.

#### Disposal of Spoil Banks

Unspread spoil – When spoil banks are shaped, they shall be shaped with top and

sides smooth enough to permit mowing or disking.

Spread spoil – See Engineering Specifications, Spoilbank Spreading.

Spoil shaped for a road – Where spoil is to be placed and used as a road, it shall be shaped as shown on the plans.

All spoil – Spoil banks shall be continuous except as shown on the plans or staked in the field.

#### Berms

Unless spoil deposited by dragline is spread at the time the channel is excavated, a berm shall be left between the top edge of the channel and the edge of the spoil. See Engineering Standard, Drainage Main or Lateral.

#### Structures and Vegetation

Structures such as pipe drops, drop inlets, or chutes, shall be installed to the lines and grades as shown on the plans.

When specified in the plans, vegetation shall be established on channel banks for erosion control.

#### Recessed Inlets

If structures are not installed, recessed inlets shall be excavated where a shallow channel or drain enters a deeper channel unless the technician determines such protective measures are not needed.

#### Bridges and Culverts

Where existing bridges are to be left without modification, the channel cross section under the bridge shall be excavated to the designed cross sectional area.

Where new bridges are installed, they shall not obstruct flow below the hydraulic gradient, except for piling.

Culverts in the sizes and lengths specified in the plans shall be installed to grade.

The minimum culvert length shall be computed by the formula  $L = W + 2SH$  where:

L = minimum culvert length

W = top width of fill over culvert

S = side slopes of fill over culvert

H = height of fill measured from ditch

bottom grade

(culvert invert).

#### Checking for Completion

Open channel shall be checked in accordance with procedures given in "Engineering Notekeeping, Open Channel."

#### NOTEKEEPING

#### Design Survey

##### General

Design surveys shall be made in accordance with procedures given in (1) the National Engineering Handbook, Section 16, and (2) the Louisiana Supplement to the Engineering Field Manual for Conservation Practices.

Refer to (1) TR-62 Re: Standard Format for Engineering Notes, and (2) Louisiana Supplement to the Engineering Field Manual for Conservation Practices, for format for notekeeping.

Record stations where right-of-way clearing will begin and end on design survey or construction layout notes.

#### Construction Layout

Set only enough well-marked stakes to guide the construction equipment operator in constructing the drainage ditch and structures.

The amount of staking done for any ditch shall be no more than that required by the contractor or cooperator to excavate to planned grades, dimensions and specifications. Use of cut sheets is recommended.

#### Construction Check

Reference survey notes to bench marks.

All channels shall be chained either during the design survey, construction layout or construction check. However, lengths of ditches may be determined by pacing or scaling on aerial photographs when no ASCS cost share is involved and payment will not be made on a yardage basis.

As a minimum, take ditch bottom profile shots of the completed ditch once every 500 feet, plus one shot at each end of the ditch. Additional profile shots shall be taken if the ditch bottom appearance indicates a need.

The cross section shall extend across the

spread spoil bank. If not spread, extend the cross section to the slope edge of the unsprayed spoil, and indicate the berm on the survey notes.